Claims

1. A method for the commutation of electromechanical, commutatorless actuators, more particularly of permanent magnet motors and reluctance motors, having a rotor and a stator including at least one stator winding (W1, W2) that is/are operated with a constant current (I), characterized in that

- a reference constant current is applied to at least one winding (W1, W2) of the actuator,
- a stationary state is awaited in which the rotor is at standstill,
- a value that represents the voltage applied to the winding of the actuator in the stationary state is determined as the reference commutation value x_0 for the commutation voltage,
- and while the motor is running, the moment T is determined in which
  - in the case of an operation with the reference constant current, the reference value appears or is being passed by, or
  - in the case of an operating current that deviates from the reference current, a commutation value that is calculated from the reference value for the prevailing operating current appears or is being passed by,
- and in that the commutation is effected a predetermined time difference after the moment T, which time difference is greater than or equal to zero and is chosen such that essentially no polarity change of the actuator torque occurs.

2. The method according to claim 1, characterized in that the actuator comprises one or two windings (W1, W2).

3. The method according to one of claims 1 or 2, characterized in that the time difference is equal to zero.

4. The method according to one of claims 1 to 3, characterized in that the constant current (I_{PWM}) is adjusted by repeatedly switching the supply voltage U_S on during a duration T_{ON} and off during a duration T_{OFF}, a switching ratio being equal to T_{ON} divided by the sum of T_{ON} and T_{OFF} ($d = T_{ON}/[T_{ON} + T_{OFF}]$), and the reference commutation value being the reference switching ratio $d_0 = T_{ON0} / (T_{ON0} + T_{OFF0})$ or a value that represents the latter.

5. The method according to claim 4, characterized in that the reference commutation value is on-time T_{ON} while off-time T_{OFF} is constant.

6. The method according to one of claims 1 to 5, characterized in that during the measurement of the reference commutation value, the constant current is applied to all windings (W1, W2) of the actuator and the reference commutation values for the windings are measured individually in order to be able to perform the commutation at the respective commutation value that is determined for each winding.

7. The method according to one of claims 1 to 8, characterized in that after applying the reference constant current, a specified time T_{wait} is allowed to elapse after which the stationary state is reached.

8. The method according to one of claims 1 to 6, characterized in that after applying the reference constant current while the reference commutation value is being

measured, one waits until the reference commutation value has no longer changed for a specified time in order to determine that the stationary state has been reached.

9. The method according to one of claims 1 to 8, characterized in that in the case of an operating constant current I_S that deviates from the reference current I_0, the momentary commutation value x is calculated from the reference value x_0 by means of the formula:

$$x = x_0 * I_S / I_0.$$

10. The method according to one of claims 5 to 9, characterized in that the sum T_{CH0} of the off-time T_{OFF0} and the on-time T_{ON0} that are applicable for the commutation is kept constant such that T_{ON0} is proportional to switching ratio d_0 in order to allow a simpler conversion of T_{ON0} to different operating conditions, more particularly a different operating current and/or voltage.

11. The method according to claim 10, characterized in that the value of T_{ON0} is set to a value that is convenient for a binary computing unit by varying the sum T_{CH0} during a measurement of the reference commutation value while the motor is at standstill, more particularly a value near the maximum value of the numerical range of the computing unit and/or a value near an integral power of 2.

12. The method according to one of claims 4 to 11, characterized in that when supply voltage U_S varies, the sum T_{CH} of on-time T_{ON} and off-time T_{OFF} for the commutation switching ratio is determined by means of the formula

$$T_{CH} = \frac{U_S}{U_{S0}} \cdot T_{CH0}$$

where T_{CH0} is the sum of the reference switching ratio and U_{S0} is the supply voltage during the measurement of the reference switching ratio.

13. The method according to claim 12, characterized in that off-time T_{OFF} is determined as the difference between switching time sum T_{CH} and on-time T_{ON} while T_{ON} is not being varied.

14. Device for implementing the method according to one of claims 1 to 13, characterized in that drivers (D1, D2) for supplying the windings (W1, W2) of a commutatorless electromechanical actuator with a constant current and a control unit (1) comprising a digital processor and a memory are provided, the drivers (D1, D2) receive a control signal from the control unit (1) which determines the current in the associated winding and the control unit receives a respective signal (8) from each driver, which signal is a measure of the voltage applied to the winding, a program for controlling the processor being stored in the memory upon whose execution by the processor the control unit (2) performs the method.

15. Application of the method according to one of claims 1 to 13 for the vibration-free control of servomotors, more particularly of low power servomotors in vehicles such as actuators for ventilation flaps, hydraulics, pneumatics, and headlights.